REMARKS

Entry of this Amendment is proper because it serves to narrow the issues on appeal and does not require further search by the Examiner.

Claims 29-39 and 41-54 are all the claims presently pending in the application. Claims 29, 32, 36, 41 and 45-46 have been amended to more particularly define the invention. Attached hereto is a marked-up version of the changes made to the specification and claims by the current Amendment.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 29, 34-36, 41-42 and 45-46 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Ohata et al. (U.S. Patent No. 4,837,186). Claims 30, 32-33 and 47-49 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Ohata et al. (U.S. Patent No. 4,837,186), or alternatively under 35 U.S.C. § 103(a) as being unpatentable over Ohata. Claim 31 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohata et al. (U.S. Patent No. 4,837,186). Claims 37-39 and 43-44 stand rejected under 35 U.S.C. § 103(a) as bing unpatentable over Ohata et al. in view of Tanaka (JP-10-303385).

These rejections are respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

The claimed invention is directed to a semiconductor device (e.g., a hybrid semiconductor substrate) having a bulk silicon region including single crystal silicon, and a silicon-on-insulator (SOI) region. The SOI region includes an insulator layer which is formed beneath an upper portion of the single crystal silicon and has at least one lateral end portion adjacent to a lower portion of the single crystal silicon, and at least one isolation oxide formed in the upper portion of the single crystal silicon so as to form at least one island of single crystal silicon on an upper surface of the insulator layer. Further, the upper portion of the single crystal silicon and the lower portion of the single crystal silicon have the same

crystal orientation. Importantly, the upper portion of the single crystal silicon includes crystallized epitaxial silicon which is grown from the lower portion of the single crystal silicon.

Conventional substrates having an SOI region are formed either by separation by implantation of oxygen (SIMOX) or by a cladding process where an oxide layer is formed in a first surface of a first substrate, a second substrate is bonded to the first surface, and elements are then formed in the second substrate. However, neither of these processes form a semiconductor device having an SOI region in which the upper portion of the single crystal silicon (e.g., a portion above the insulator layer) includes crystallized epitaxial silicon which is grown from the lower portion of the single crystal silicon.

The claimed semiconductor device, on the other hand, may have an SOI region in which the upper portion of the single crystal silicon includes crystallized epitaxial silicon which is grown from the lower portion of the single crystal silicon. Specifically, the upper portion of single crystal silicon may be formed over the insulator layer by depositing amorphous silicon on the insulator layer and the lower portion of the single crystal silicon, and then crystallizing (e.g., by annealing) the amorphous silicon by using the lower portion of the single crystal silicon as a crystal growth seed.

As a result, the claimed device has a higher substrate quality than conventional devices. Specifically, the upper portion of the single crystal silicon may be substantially free of defects. More specifically, the silicon layer on the insulator layer can have a near ideal crystal structure, which is not provided by conventional devices.

II. THE PRIOR ART REFERENCES

A. The Ohata Reference

The Examiner alleges that Ohata anticipates the claimed invention. Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by Ohata.

Ohata discloses a silicon semiconductor substrate with an insulating layer therein. The silicon semiconductor substrate includes a first silicon plate, an insulating layer embedded in the first silicon plate so that the surfaces of the silicon plate and the insulating

layer are in a mirror surface, and a second silicon plate united with the first silicon plate and the insulating layer at the mirror surface of the first silicon plate and the insulating layer (Ohata at Abstract).

However, contrary to the Examiner's allegations, Ohata does not teach or suggest "*wherein said upper portion of said single crystal silicon comprises crystallized epitaxial silicon which is grown from said lower portion of said single crystal silicon*" as recited in claim 29, 41 and 46, and similarly recited in claim 45. As noted above, conventional substrates having an SOI region are formed either by separation by implantation of oxygen (SIMOX) (Application at page 5, lines 2-10) or by a cladding process where an oxide layer is formed in a first surface of a first substrate, a second substrate is bonded to the first surface, and elements are then formed in the second substrate.

However, a substrate prepared by the SIMOX process necessarily includes a high defect density (e.g., number of defect counts per unit area) (Application at page 5, lines 3-6). Specifically, the implantation of oxygen causes a high number of defects in the silicon layer through which the oxygen is implanted. Therefore, a SIMOX the silicon over the insulator region may have a low quality.

On the other hand, a substrate prepared by a cladding process involves two silicon crystals bonded together. The cladding process requires many steps and therefore, the resulting substrate is expensive. Moreover, the resulting substrate necessarily has an upper layer having a first silicon crystal, and a lower layer having a second silicon crystal. Therefore, unlike the SIMOX substrate which may include only one single silicon crystal layer (although, heavily damaged), the substrate formed by the cladding process includes two silicon crystals which may have a different crystal orientation from one another.

The claimed semiconductor device, on the other hand, may include an SOI region in which the upper portion of the single crystal silicon includes crystallized epitaxial silicon which is grown from the lower portion of the single crystal silicon (Application at Figure 1D; page 9, lines 18-22). Specifically, in the claimed device, the upper portion of single crystal silicon may be formed over the insulator layer by depositing amorphous silicon on the insulator layer and the lower portion of the single crystal silicon, and then growing (e.g., [illegible] the insulator layer and then crystallizing (e.g., by

annealing) the amorphous silicon by using the lower portion of said single crystal silicon as a crystal growth seed. (Application at page 3, line 18-page 4, line 12; page 9, lines 12-22).

Unlike the substrate prepared by the SIMOX process, the claimed substrate (and device) may include an upper portion (e.g., a portion over the insulator layer) which does not have a high defect density. Instead, in the claimed device "defective areas" may be limited to only the edges of the insulator layer and the seam where the crystallization of the epitaxial silicon from both edges meet (Application at page 10, lines 10-12; Figure 1D). Therefore, these "defective areas" may be easily removed and replaced with oxide islands, so that substantially defect-free silicon may remain between the oxide islands.

In addition, unlike the substrates formed by the cladding process, the claimed substrate does not require the bonding together of two separate silicon crystals. Instead, the claimed device may be formed of a single silicon crystal, and may, therefore, have a same crystal orientation. Thus, the claimed device has a higher substrate quality than conventional devices (Application at page 5, lines 2-10).

Clearly, Ohata does not teach or suggest these novel features. Indeed, the device in Ohata is a completely different structure than the claimed device. Further, Ohata does not even address at least one of the problems (e.g., defects in the silicon of the SOI region caused by the SIMOX process) which the claimed substrate is intended to address.

Further, Ohata merely discloses a device formed according to a process which is similar to the cladding process described above. Specifically, the Ohata device includes a first monocrystalline silicon plate, an insulating layer embedded in the first silicon plate, and a second monocrystalline silicon plate bonded to the first silicon plate (Ohata at Abstract; Figure 8A; col. 4, lines 1-47).

Therefore, as discussed above with respect to the cladding process, the Ohata device will necessarily include two silicon crystals which may have a different crystal orientation from one another. This is completely different from the claimed substrate (or device) in which the upper portion of the single crystal silicon comprises crystallized epitaxial silicon which is grown from the lower portion of the single crystal silicon.

Further, Applicant respectfully submits that the unique features of the claimed substrate (e.g., an upper portion including crystallized epitaxial silicon) clearly result in a

"distinct structure being produced". Specifically, Applicant respectfully submits that the claimed substrate results in the upper portion and the lower portion of the single crystal silicon having the same crystal orientation. This novel feature is clearly not taught or suggested by Ohata.

The Examiner states that "Ohata et al. do not distinguish or disclose any differences between the two single crystal silicon layers" and "[t]herefore, in absent of evidence to the contrary, it is held that the first and second single crystal silicon layers are identical, thus rendering them as having the same crystal orientation". However, this is clearly incorrect.

First, the Examiner here is basically relying on the incorrect logic that "reference x does not teach that feature y is not present, so it may be assumed that the feature y is present". This is clearly incorrect and contrary to the principle of fundamental fairness which is due the Applicant. Instead, Applicant respectfully submits that the Examiner must show that the reference does teach or does suggest a feature and cannot merely rely on the logic that the reference does not disclose that the feature is not present.

In this case, it is clearly possible for the two monocrystalline silicon plates 21, 22 to have a different crystal orientation. Regardless of whether it would be desirable to have a same crystal orientation, as alleged by the Examiner, the fact is that it is clearly not taught or suggested by Ohata. Therefore, Therefore, the Examiner cannot properly rely on Ohata for teaching an upper portion and a lower portion of single crystal silicon having a same crystal orientation.

Therefore, Applicant submits that Ohata does not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. The Tanaka Reference

The Examiner alleges that Tanaka would have been combined with Ohata to form the claimed invention (as recited in claims 37-39 and 43-44). Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

rming a hybrid element on a SIMOX wafer.

Specifically, a silicon substrate 3 is exposed by selectively removing a silicon layer 1 and an insulating layer 2 from a silicon-on-insulator (SOI) substrate. The desired semiconductor elements 11 are respectively formed on the exposed silicon substrate 3 and the silicon layer 1 (Tanaka at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different matters and different problems. Specifically, Ohata is merely directed to a cladding type process of forming an insulating layer in a substrate, whereas Tanaka is directed to a well-known SIMOX process for forming a logic circuit and memory cell on a substrate. Clearly, these references teach away from each other and would not have been combined by one of ordinary skill in the art.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner supports the combination by merely stating that "[i]t would have been obvious ... to form a DRAM memory device on the silicon bulk and a MOSFET logic device on the SOI region, as taught by Tanaka, in Ohata et al.'s device in order to provide a hybrid device wherein the DRAM can operate at high speed with less power consumption and the logic circuits are adequately isolated" which is merely a conclusory statement and insufficient to support the combination of these disparate references.

Moreover, like Ohata, Tanaka does not teach or suggest "*wherein said upper portion of said single crystal silicon comprises crystallized epitaxial silicon which is grown from said lower portion of said single crystal silicon*" as recited in claim 29, 41 and 46, and similarly recited in claim 45. As noted above, unlike conventional substrates which are formed by a SIMOX or cladding process, the claimed substrate (and device) includes an SOI region in which the upper portion of the single crystal silicon includes crystallized epitaxial silicon which is grown from the lower portion of the single crystal silicon (Application at Figure 1D; page 9, lines 18-22).

Specifically, in the claimed device, the upper portion of single crystal silicon may be formed over the insulator layer by depositing amorphous silicon on the insulator layer and

silicon, and then growing (e.g., depositing) the single

crystal silicon over the insulator layer and then crystallizing (e.g., by annealing) the amorphous silicon by using the lower portion of said single crystal silicon as a crystal growth seed. (Application at page 3, line 18-page 4, line 12; page 9, lines 12-22).

Clearly, Tanaka does not teach or suggest these novel features. Indeed, the device in Tanaka is a completely different structure than the claimed device. Further, Tanaka does not even address at least one of the problems (e.g., defects in the silicon of the SOI region caused by the SIMOX process) which the claimed substrate is intended to address.

Tanaka merely describes a "hybrid element" formed on a SIMOX or stuck SOI substrate (e.g., Tanaka at Figures 2(a)-2(c)). Nowhere does Tanaka teach or suggest an SOI region in which the upper portion of the single crystal silicon includes crystallized epitaxial silicon which is grown from the lower portion of the single crystal silicon. Indeed, the Examiner basically concedes that Tanaka does not teach or suggest the novel features of the claimed substrate, saying "Tanaka was not cited to teach an artisan that the upper portion and the lower portion of the single crystal silicon layer have the same crystal orientation"

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

III. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 29-39 and 41-54, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

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The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 50-0510.

Respectfully Submitted,

Date: 3/28/03

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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that the foregoing Amendment was filed by facsimile with the United States Patent and Trademark Office, Examiner Ori Nadav, Group Art Unit # 2811 at fax number 703-872-9319 this 28th day of March, 2003.

Phillip E. Miller
Reg. No. 46,060

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend the claims to read as follows:

29. (Thrice Amended) A semiconductor device comprising:

a bulk silicon region comprising single crystal silicon; and

a silicon-on-insulator (SOI) region comprising:

an insulator layer which is formed beneath an upper portion of said single crystal silicon and has at least one lateral end portion adjacent to a lower portion of said single crystal silicon; and

at least one isolation oxide formed in said upper portion of said single crystal silicon so as to form at least one island of said single crystal silicon on an upper surface of said insulator layer,

wherein said upper portion of said single crystal silicon and said lower portion of said single crystal silicon have a same crystal orientation, and

wherein said upper portion of said single crystal silicon comprises crystallized epitaxial silicon which is grown from said lower portion of said single crystal silicon.

41. (Four Times Amended) A hybrid bulk silicon and silicon-on-insulator (SOI) substrate, comprising:

an insulator layer which is formed beneath an upper portion of single crystal silicon and has at least one lateral end portion adjacent a lower portion of said single crystal silicon; and

a plurality of isolation oxides formed in said upper portion of said single crystal silicon so as to form at least one island of said single crystal silicon on an upper surface of said insulator layer,

wherein said upper portion of said single crystal silicon and said lower portion of said single crystal silicon have a same crystal orientation, and

wherein said upper portion of said single crystal silicon comprises crystallized

epitaxial silicon which is grown from said lower portion of said single crystal silicon.

45. (Four Times Amended) A semiconductor device comprising:

a bulk semiconductor region comprising semiconductor substrate; and

a semiconductor-on-insulator region comprising:

an insulator layer which is formed beneath an upper portion of said semiconductor substrate and has at least one lateral end portion adjacent to a lower portion of said semiconductor substrate; and

at least one isolation oxide formed in said upper portion of said semiconductor substrate so as to form at least one island of said semiconductor substrate on an upper surface of said insulator layer,

wherein said upper portion of said semiconductor substrate and said lower portion of said semiconductor substrate have a same crystal orientation, and

wherein said upper portion of said semiconductor substrate comprises crystallized epitaxial silicon which is grown from said lower portion of said semiconductor substrate.

46. (Thrice Amended) A semiconductor device comprising:

a single crystal silicon substrate having a lower portion and an upper portion;

an insulator layer which is formed beneath said upper portion of said single crystal silicon substrate and has at least one lateral end portion adjacent to said lower portion of said single crystal silicon substrate; and

at least one isolation oxide formed in said upper portion of said single crystal silicon substrate so as to form at least one island of said single crystal silicon substrate on an upper surface of said insulator layer,

wherein said upper portion of said single crystal silicon substrate and said lower portion of said single crystal silicon substrate have a same crystal orientation, and

wherein said upper portion of said single crystal silicon comprises crystallized epitaxial silicon which is grown from said lower portion of said single crystal silicon.